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nation. The star-dial, from which the Right Ascensions can be read directly, is of almost indispensable convenience. The driving-clock drives regularly, and the entire mounting is of the highest mechanical excellence. The telescope has as accessories a micrometer, by WARNER & SWASEY, provided with electric illumination; a polarizing helioscope, and a battery of positive and negative eye-pieces. The transit-room contains a small universal instrument by BAMBERG, a chronograph by FAUTH & COMPANY, a Bond sidereal chronometer, and a sidereal clock.

These instruments, together with a portrait lens of five inches aperture and a Browning equatorial of four inches aperture, which for many years have been the property of the university, constitute a nucleus around which the university authorities hope to collect a more complete equipment.

The observatory bears the name of Dr. DANIEL KIRKWOOD, the eminent astronomer, who for nearly half a century was a member of the faculty of the university, and who by his manly qualities won the lasting esteem of his students and colleagues, and by his devotion to his science a lasting name among his contemporaries.

The observatory was formally dedicated on May 15, 1901. The dedicatory address was given by Professor W. J. HUSSEY, Astronomer in the Lick Observatory. He spoke of "Astronomy and Modern Life." President JOSEPH SWAIN spoke of "Personal Recollections of Dr. KIRKWOOD."

We of the observatory take this opportunity to acknowledge our obligations to Professor HUSSEY for his thoughtful address and his kindly interest in our equipment.

DANIEL KIRKWOOD.*

By JOSEPH SWAIN.

At Riverside in California there died in his eighty-first year an aged man who was of more interest to the people who have known him and loved him (for to have known him was to love him) than all the groves of orange and palm-trees, than all the snow-capped mountains, the Italian skies, the unequaled climate, or magnificent landscapes of that favored land. It is of this venerable man I wish to speak to you on this occasion.

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* An address delivered at the dedication of the Kirkwood Observatory, University of Indiana, May 15, 1901.

The city of Riverside covers several square miles of territory and has hundreds of orange-groves and vineyards within its corporate limits. In one of these groves, seven acres in extent, lived DANIEL KIRKWOOD, the subject of this sketch.

While Professor KIRKWOOD passed his declining years in the picturesque surroundings of Southern California, it is not there that he made his name and lived the best part of his life. His twenty-seven years of active service in the interest of manhood, science, and higher education in general in Indiana are the brightest and best years of his life.

The esteem in which Dr. KIRKWOOD was held in Bloomington is indicated by the fact that the street leading to the university bears his name, and that every old citizen points out with evident pride the house in which he lived on the corner of College Avenue and Tenth Street. Indiana University has appropriately expressed its appreciation by naming one of the halls in his honor and also the new astronomical observatory.

DANIEL KIRKWOOD was of Scotch-Irish descent, his grandfather coming from Ireland in 1771, and settling in Delaware. His parents, JOHN and AGNES (HOPE) KIRKWOOD, were both born in this country. Professor KIRKWOOD was born in Hartford County, Maryland, September 27, 1814. His early life was spent on the farm, his first attendance at school being in his native county. Having little taste for farming, he entered the York County Academy, at York, Pennsylvania, in 1834. He had taught a country school at Hopewell, York County, the previous year. A pupil in this school wishing to study algebra, asked young KIRKWOOD to instruct him. A copy of BONNYCASTLE'S algebra was secured, and the two studied together, Mr. KIRKWOOD leading the way. Professor BRUNNOW, at one time professor of astronomy at Ann Arbor, once had a class of one in mathematical astronomy consisting of the afterward famous Professor WATSON. Professor BRUNNOW said he had never had so fine a class as this one either before or since. It is safe to say that no class of one ever had a more inspiring teacher of algebra than this young man in 1833 at Hopewell in Pennsylvania, for the young KIRKWOOD must have come to his first lessons in algebra with all the enthusiasm of youth and the ardor of "love at first sight." He was elected first assistant and mathematical instructor in York County Academy in 1838. While here he trained many students in mathematics, one of whom, SAMUEL R. FRANKLIN, afterward became superintendent of the Observatory at Washington. Professor KIRKWOOD resigned his position in 1843 to accept the principalship of the Lancaster High School, Pennsylvania, and a few years later he became principal of the Pottsville Academy. In 1845 he was married to Miss SARAH A. MCNAIR, of Newton, Bucks County, Pennsylvania. He was professor of mathematics in Delaware College from 1851 to 1856, the last two years being its president. In speaking to me one day about this period of his presidency, he said, "Concerning that, the less said the better." He evidently did not enjoy the responsibility of the president's position. He was a student and teacher, and set a noble example which cannot be overestimated, but he did not like to assume or use authority. He was always the embodiment of loyalty to the institution he served, but begged to be excused from anything which brought him into public notice. He shrank intuitively from public gaze or appreciation. This was so strong that he could hardly be induced to give a public lecture, and never an impromptu address. I remember at one time there was a public gathering in the College Chapel at Bloomington. Some impromtu speeches had been made, and Dr. KIRKWOOD, being immensely popular with the students, was called upon by them to make a speech. The President of the University, who was presiding, stepped to him and asked him if he would not respond. He begged to be excused, and asked the President to say that as he had often excused the students from recitations in the classroom, he trusted they would now excuse him. This created a laugh at the expense of the students, and they did not call on him again that day.

He was a member of the Presbyterian Church, and was always a faithful attendant at its services. He was a teacher in the Sunday-school. For many years he taught a class of boys from twelve to fourteen years of age. I remember once he told me, with evident gratification, that these boys decided that they would not have any other teacher when he went away. He was a great reader of the Bible, preferring to read it in the Greek. In NORTHROP'S book, "A Cloud of Witnesses," there is a letter from Dr. KIRKWOOD which explains itself. It is as follows :—

"I am asked to give my opinion of Christ and the Bible. Let me say in answer to the old question, 'What think ye of Christ?' that his name is above every name. I regard him as the Divine Saviour of men. I accept him as my Saviour, and place all my hope of Salvation in him. I accept the Scriptures as a revelation of what man is to believe concerning God, and what duty God requires of man."

Professor KIRKWOOD deplored the fact that there has been a tendency to skepticism among some scientific men. He says:

> "It will be noted, however, by careful observers that this tendency is more distinctly marked among specialists, men whose minds have been biased by continued and almost exclusive devotion to physical research, while the claims of Christianity and the evidence of its truth have been persistently ignored. But our own time is no exception to the historic fact that in all ages minds of the broadest culture have accepted Christianity."

He thought there is no necessary antagonism between physical science and Christianity, and the study of physical science was not of necessity prejudicial in the student himself to a personal acceptance of Christianity. Dr. KIRKWOOD had a profound belief in God and his controlling influence over the affairs of men. I remember being present at a certain organization when resolutions of sympathy were being passed on account of the death of a certain young man. Dr. KIRKWOOD had written the resolutions and had read them to the meeting. A member of the meeting objected to the form of his expressions as hackneyed and the sentiment as not being in accordance with the belief of all men. Dr. KIRKWOOD said with courtesy but decision and the emphasis of deep conviction, "I believe just that." He said no more, but the resolution was adopted as read.

I quote the following from an article by Professor ALEY:—

> "His study of the stars has strengthened his belief in God. To his mind, with its faith strengthened by a firm grasp of the mightiest works of God, unbelief is impossible, and he can hardly understand how honest unbelief can exist in another. Some years ago he gave a beautiful demonstration before a class. A student asked: 'Is that always true?' 'Yes,' said he, 'as true as that there is a God in heaven.' 'But,' said the student, 'what would you say to him who does not believe in God?' Straightening up to his full height, and with glittering eye he said, 'I would try to keep my temper and get away as quickly as possible.' The writer well remembers his first visit to Bloomington. He went into a barber-shop, and, as it was a rainy day, there was quite a crowd of loafers, white and black, professional men and day laborers. By chance the conversation changed to men. Every man present found his ideal in DANIEL KIRKWOOD. No man ever received a higher tribute of praise. His life was so simple, so pure, and so true that the student, the philosopher, and the common man can all find in him the ideal."

A friend of mine once lived for a time in Dr. KIRKWOOD'S house. One evening something attracted his attention in the next room. He listened and found Dr. KIRKWOOD was reading the Scriptures aloud to his wife. The reading was followed by a solemn prayer. My friend thought to himself: "Here is a genuine Christian. He is following the teaching of Christ—'But thou when thou prayest, enter into thy closet, and when thou hast shut thy door, pray to thy Father which is in secret, and thy Father which seeth in secret shall reward thee openly.'"

The domestic life of Dr. KIRKWOOD was very beautiful. He was at his best at home. His fireside was as attractive to him as his study. His wife was a quiet, domestic woman, who found her chief enjoyment in her home and with her friends. She was only interested in the scientific work of her husband as a loving and dutiful wife who was interested in everything connected with him. She was the devoted helper of a truly great man. When visitors happened in, she always wanted him to talk to them and entertain them. She felt that she had done her part if she encouraged him to talk. On such an occasion it was a genuine pleasure to see the enjoyment she derived from his conversation.

Professor KIRKWOOD was first introduced to the scientific world by the publication, in 1849, of his analogy between the periods of the rotations of the primary planets. The statement of the law is as follows: The square of the number of rotations made by a planet during one revolution around the Sun is proportional to the cube of the diameter of its sphere of attraction. PROCTOR, the eminent English astronomer, gave KIRKWOOD the name of "the KEPLER of America," after the announcement of KIRKWOOD'S Law. This was fitting, as the form of the law is similar to KEPLER'S Third Law: The square of the number of the revolutions of a planet is proportional to the cube of its mean distance from the Sun. Indeed, the form of the Law of KEPLER first suggested to Dr. KIRKWOOD the form of this law. This law has always been regarded by mathematicians as a confirmation of the Nebular Hypothesis. The law is an empirical one, and has never been demonstrated by rigid mathematical analysis. It is now in the same stage of KEPLER'S Third Law before it was shown to be the direct result of the Law of Gravity. The mathematician who is able to give it a rigid mathematical demonstration is sure of remembrance by a grateful posterity.

When about fifty asteroids were known in the solar system, Professor KIRKWOOD conceived the notion that in those spaces where simple commensurability with *Jupiter* occurs, there must be gaps in the asteroid zone. It was then, however, only a theory, as the number of asteroids sufficient for its verification were not known. Yet on its first announcement it met with favor, and Mr. PROCTOR, the eminent astronomer, accepting Professor KIRKWOOD'S notion, wrote in 1870: "We may assume that when many more asteroids have been discovered, that the law will appear more distinctly." The number of asteroids known were then sufficient only to indicate the law; now the number discovered and orbits computed have reached 450. Professor KIRKWOOD has shown that these gaps actually exist and assigned a physical cause for them. He originally published his discoveries concerning these chasms in the Proceedings of the American Association for the Advancement of Science in 1866. Circumstances, however, which need not here be stated, induced Professor KIRKWOOD to give a résumé of his discussions in the Proceedings of the American Philosophical Society for 1883. From this paper the following is taken :—

> "In those parts of the zone of minor planets where a simple relation of commensurability would obtain between the period of an asteroid and that of *Jupiter*, the original planetary matter was liable to great perturbations. The result of such disturbance by the powerful mass of *Jupiter* was the necessary formation of gaps in the asteroid zone."

Professor KIRKWOOD was the first to show that the divisions of *Saturn's* rings are due to the same cause as the gaps in the zone of asteroids. The treatise of Dr. MEYER, of Geneva, on *Saturn's* rings published in 1883, and leading to the same or a similar result, is a gratifying confirmation of Professor KIRKWOOD'S discovery.

He has contributed nearly two hundred articles to various scientific and popular journals. He is the author of a well-known book on comets and meteors, as well as an earlier book on meteoric astronomy. He is also the author of a little book on the asteroids. He was at one time mathematical editor of the *Indiana School Journal*. He also contributed popular articles for several years to the *Indianapolis Journal*. The astronomical articles in *Appleton's Annual Encyclopædia* were written for several years by him. *The Popular Science Monthly*, *The Analyst*, *American Journal of Science*, *The Sidereal Messenger*, *Nature*, and other journals, were always glad to get articles from his pen. Dr. KIRKWOOD'S writings are all characterized by simplicity, brevity, and purity. Such ability as he had to say clearly and forcibly what he had to say is possessed by few.

In September of 1889 he asked me to come to his study in the afternoon. I went and found that he wanted to see me about some books. He thought that the greater part of his library would no longer be useful to him, and that it should be placed where it would be of most service. He wanted to give some books to the college library, and he wanted me to select some that the university should buy. We found among his books several unpublished manuscripts. Professor GREEN and I suggested to him that the library would be glad to get these manuscripts, but he refused. They were manuscripts that he concluded, after mature consideration, he would not publish, and he feared their future publication if given to the library, so he consigned them to the fire, much to our disappointment. Dr. KIRKWOOD once having a clear notion of what he wished to do, was very slow to alter his determination. He made up his mind slowly and after very critical examination of the subject in hand, but relied upon his conclusion when reached. Once I suggested to him that he should have all his writings, scattered in numerous magazines, collected together and edited during his lifetime, so that it would be known just what he had done, and his articles would then be much handier for reference. His reply was this: "Anything that deserves to live will, and that which does not deserve it ought to die." He was not troubling himself about his future fame. His theory was that if he had not done anything worthy of future reference he wanted to be forgotten. He was not troubled by any thirst for a false and fictitious glory.

Dr. KIRKWOOD'S position among scientific men and non-scientific men was unusual. He had the respect and confidence of both alike. The most selfish man seemed to lose his selfishness in his presence. Every one seemed to instinctively feel that he was a great man, and a criticism upon him would be only acknowledging one's own lack of appreciation. While it is as a genial and good man that most of the people who have come into personal contact with Professor KIRKWOOD have known him, it is as a scientist that he is best known to the people of the United States and of Europe. He is probably better known in Great Britain than he is in America. He seemed to have through his writings the warm friendship of astronomers everywhere, even though they had not met him. Several years ago, when PROCTOR, the eminent English astronomer, was in this country, this incident occurred: PROCTOR lectured in Indianapolis. After the lecture a professor from a sister institution approached him and invited him to his town to lecture the next night. PROCTOR said: "No; I came to America to see Dr. KIRKWOOD. To-morrow is my opportunity, and I am going to Bloomington to see him."

Eighteen years ago, when I was an assistant of Dr. KIRKWOOD, I wrote and published this paragraph:—

> "'When I die, I want to go where Dr. KIRKWOOD goes,' was the simple eulogy of one of his admirers. Whatever may be said of this sentiment, certain it is that during fifty years as a teacher, he has gained from his students such universal love and admiration as few men can enjoy, and while as a mathematician he has made many valuable contributions to science, as a genial, temperate, and genuine man, he has solved the problem of gracefully growing old."

In intellect he was keen, logical, and far-seeing. In integrity he was without reproach. He was "spotless before the world." In private character he was pure as an infant. He was in sympathy with humanity. He was as natural as a child and as free from self-conceit as the "lilies of the field." He saw and spoke the truth. The laws of Nature were to him the laws of God. The heavens indeed declared His glory. In revealing the secrets of the stars he revealed the beauty of his life. KIRKWOOD the scientist we admire, but KIRKWOOD the man we love. These characteristics made DANIEL KIRKWOOD one of the greatest of Indiana's roll of heroes and one of the most lovable of men of any country or age.

PLANETARY PHENOMENA FOR SEPTEMBER, OCTOBER, NOVEMBER, AND DECEMBER, 1901.

By MALCOLM McNEILL.

SEPTEMBER.

The Sun crosses the celestial equator and autumn begins September 23d, 10 A.M. Pacific time.

Mercury is an evening star throughout the month, having passed superior conjunction on August 27th. At the close of